Blacklock Restoration Project

Monitoring Plan

September 2006

Prepared by
Division of Environmental Services
Department of Water Resources

in cooperation with
U.S Bureau of Reclamation
California Department of Fish and Game
Suisun Resource Conservation District

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INTRODUCTION

Project Overview

This monitoring program is proposed to accompany the Blacklock Restoration Project. The Blacklock site is located in the northeast Suisun Marsh bordering Little Honker Bay (Figure 1). The parcel is approximately 70 acres, which includes about 67 acres seasonal wetland and 3 acres upland/levee. Since July 2006, the property has been a muted tidal wetland because of deteriorating levee conditions. When the permit applications were submitted in June 2006, the site conditions included a diked, managed marsh, a partial remnant network of sloughs, an interior borrow ditch, and seasonally and perennially ponded areas. There is fringing tidal marsh on the outboard side of the exterior levees.

The proposed project is to construct a 65 foot-long levee breach during October 2006 to restore this managed wetland property to a fully functioning tidal wetland. This breach will be located along Little Honker Bay (Figure 2). A second breach, located along Arnold Slough, was originally proposed and included in the project description of the permit application. This breach may be constructed at a later date if necessary (see Adaptive Management).

Goals of Monitoring

The goals of monitoring include:

1. Meeting terms and conditions and requirements of regulatory permits;

2. Avoidance of adverse impacts from construction and restoration activities;

3. Evaluating the effectiveness in meeting the goals and objectives of the restoration.

Specific monitoring components are presented as a minimum monitoring approach to meet permit conditions described in BCDC permit M06-21 (M). Although restoration of this parcel to a fully functioning tidal wetland is expected to take several years, this is a 10 year monitoring plan. A proposed schedule of monitoring activities is presented in Table 1. Details of monitoring costs, by year is presented in Table 2. The estimated cost of implementing this plan is approximately $716,000. This estimate factors in a 15% contingency to address uncertainties of projecting costs 10 years into the future.

When additional funding is secured through grants, directed funds, etc, more extensive monitoring could be conducted. Through more extensive monitoring, the Blacklock site could provide regionally specific data to inform the design and planning of future restoration efforts in Suisun Marsh including tidal marsh acreage goals described in the *Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh* currently being developed by the Suisun Charter Group. Knowledge expected to be gained from this restoration includes but is not limited to rates of sedimentation and marsh development, channel network formation and overall geomorphology, hydrology, water quality impacts, methyl mercury production, and species use.

Permit Requirements

The monitoring components described in this plan are required by San Francisco Bay Conservation and Development Commission (BCDC) permit M06-21 (M) authorizing this activity. A water quality certification was issued by the San Francisco Bay Regional Water Quality Control Board (RWQCB). The Nationwide 27 permit issued by the U.S. Army Corps of Engineers (USACE) requires that the monitoring requirements of the BCDC and RWQCB permits be implemented. All terms and conditions of the permits will be met. The US Fish and Wildlife Service (FWS) authorization (concurrence with not likely to affect determination) required preconstruction SMHM surveys and dissolved oxygen monitoring. The National Marine Fisheries Service (NMFS) also provided concurrence with the not likely to affect determination for Endangered Species Act Compliance.

With tidal inundation, the Blacklock property becomes part of the 2500 acres designated as "conservation areas" in Suisun Marsh. This designation is an outcome of several years of Suisun Marsh Preservation Agreement Environmental Coordination Advisory Team (ECAT) collaboration on Suisun Marsh habitat management and conservation issues. A salt marsh harvest mouse monitoring program was developed has been implemented on the conservation areas. SMHM monitoring will be conducted on Blacklock as part of this well established long-term monitoring program.

Site Conditions and Modifications

The underlying restoration requirement for this site is subsidence reversal, as the site ranges from 3 to more than 5 feet below local mean high water. The overall approach for the Blacklock Restoration Project calls for a passive strategy in which the exterior levee is breached, natural sedimentation and plant detritus accumulation restores intertidal elevations, and natural colonization establishes the plant and wildlife communities. The project included a "pre-vegetation" element to promote these natural restoration processes; since acquisition, DWR has maintained a moist soil management strategy to encourage the growth of emergent vegetation.

Since January 2006, the site has been inundated from levee overtopping resulting from high tides. In July 2006, a hole through the levee at stn 52+00 enlarged and resulted in muted tidal conditions at the site. Currently, the site is a mix of shallow open water and remnant emergent vegetation throughout the tidal cycle.

Restoration of full tidal flows will result in changes to the habitats and biological, physical, and chemical functions of the site. Constructing the levee breach to the design specifications will allow for full tidal exchange.

Tidal flow is expected to utilize the existing remnant channels to some extent, with some new channels forming as sedimentation progresses. This design is a minimal-engineering approach that relies on natural processes to meet project goals and objectives. A detailed description of the design approach and hydrodynamic modeling conducted to determine the preferred locations is presented in the Draft Restoration Plan available on-line at http://www.iep.ca.gov/suisun/restoration/blacklock/doc/BlacklockDraftRestorationPlan_061506.pdf.

A new tidal channel network is expected to form, partially re-occupying remnant channels and otherwise forming within the newly forming tidal marsh surface. Vegetation will transition to a mix of species suited to the intertidal brackish environment, with the shallow pond bottoms becoming fully vegetated except for channels. Some open water areas may persist in the long term.

BCDC permit M06-21 (M) specified that a topographic map of the site and of the proposed modifications be submitted. Maps submitted with the permit application described existing and proposed site conditions and are

included as Appendix A. In addition, a digital elevation model of the site was prepared from an extensive elevation survey conducted in 2002 (Figure 3). A vegetation survey of the property was conducted in 1999 and 2003 as part of the Suisun Marsh Vegetation Survey. The 2003 vegetation survey is included as Figure 4. This shows the vegetation under pre-inundation conditions. Since January 2006, the site has been inundated, originally from high tide stages and overtopping levees during the winter of 2006. In July 2006, a hole in the levee at stn 52+00 expanded into a small breach, resulting in muted tidal conditions at the site. Emergent vegetation (*typha, schoenoplectus (scirpus)* and *phragmites* dominate the vegetation at the site. With full tidal inundation, the expectation is that the emergent vegetation will colonize the area formerly dominated with saltgrass *(Distichlis spicata)* and pickleweed (*Salicornia virginica)*, until elevations at the site increase enough to support a more diverse array of species.

Project Implementation

Constructed Levee Breaches

Modeling results indicate that the site drains better at low tide with two breaches on the property. Therefore, two locations, 55+00 and 25+00 are identified as preferred breach locations for the constructed breach alternative (Figure 2). Station 55+00, along Little Honker Bay would allow for an unimpeded exchange of flows during tidal cycles. Because there is no in-channel island or fringing tidal marsh here, it is expected that a breach at this location would optimize the transport of available Little Honker Bay sediments into the property to raise surface elevation through sediment deposition. In addition, a breach at this location could take advantage of the remnant tidal slough network within the property. It is unlikely that an unintended levee failure would occur at this location. The levee is wider and higher than other areas and there is remnants of riprap on the waterside slope and toe.

The second breach was to be located in the southwest corner of the property along Arnold Slough. A second breach at stn 25+00 was included in the project description for environmental documentation and permit applications. Subsequent to these documents being submitted, erosion along the levee at stn 36+00 worsened and a breach is expected to occur naturally at this location in the near future. Because this is in the vicinity of the Arnold Slough breach location, a second breach is not going to be constructed at this time.

Modeling suggests that a breach size of at least 65 feet (20 meters) would be sufficient for full tidal exchange. The levee would be excavated to -1 ft NAVD. A detailed description of hydrodynamic modeling conducted for this project is included in the Draft Restoration Plan for the Blacklock Restoration Project.

Construction Methods

The levee would be breached during one low tide cycle, and was scheduled to coincide with the lowest (projected) tide during the available construction window. The typical maintenance and construction period in the Suisun Marsh is May through October. The site would not be dewatered.

The breach will be constructed using a long-reach excavator. The breach size will be a maximum 65-foot (20 meters). The actual breach size will be determined by the equipment, the operator and the conditions at time of construction.

A maximum of 1000 yards of material would be excavated from each breach. Excavated material would be placed in the borrow ditches as ditch blocks to a level not to exceed MLLW. Any material placed in the ditches would not be compacted, but left as placed. The elevation (depth) of the breach and the elevation of the material placed in the borrow ditch will be verified at the time of construction.

Avoidance of adverse impacts during construction

Specific survey protocol was included in the project description of the permit application and environmental documents to avoid and minimize potential impacts to sensitive species during construction of the proposed levee breaches. In addition, construction Best Management Practices (BMP's) will be followed as described in the JARPA permit application, biological assessment, and CEQA/NEPA documents.

SMHM Surveys

- SMHM were surveyed at the Little Honker Bay breach location prior to excavation according the protocol specified by the USFWS and DFG. This permit (#835365-3) authorizes DWR and DFG SMHM sampling within the Suisun Marsh. Surveys were conducted for five consecutive nights, from August 27 through September 1. No SMHM were captured. Five house mice were trapped.
- Vegetation was removed from the levee slopes along an 85 foot section of the levee at the breach location (10 feet on either side of the breach). The vegetation was removed with a weed eater immediately following smhm surveys.

Dissolved oxygen in the pond

The permit application specified that dissolved oxygen be monitored within the pond prior to breaching using hand held, portable instruments, to avoid potential impacts to delta smelt. The permit application specified that water will be exchanged and circulated, to the extent possible, using the water control structure. Since the permit was submitted, the hole at stn 52+00 enlarged, creating a muted tidal wetland and allowing for more exchange of pond water with each tide. A higher volume of water is currently being exchanged through the hole than would be exchanged through the breach; however, since the water control structure is located on the opposite side of the hole, the flood and drain gates will be opened prior to the breach to maximize water exchange in the pond.

MONITORING PROGRAM ELEMENTS

Restoration Performance Criteria

As described in the Draft Restoration Plan for this project, restoration performance criteria were developed to evaluate the progress and effectiveness in meeting the goals and objectives of the project. The performance criteria for the Blacklock Restoration are:

- High tide heights inside the site will be substantially similar to those observed outside the site, within two years following a planned or unintentional breach.
- Low tide heights inside the site will be no more than 1 foot greater than those observed outside the site, within two years following a planned or unintentional breach.
- Restored marsh plain elevations will continually trend upwards.
- Native tidal marsh species will colonize and establish at the site. Native species shall be at least 50% of total vegetated areas. Species composition will be those species appropriate to the salinity regime and site elevations. It is expected that open water will remain on the site, possibly at much as 50% of total area.

Restoration Outcome Monitoring

Monitoring will both document the expected beneficial effects of this project and detect potential impediments to successful marsh restoration as well as potential adverse outcomes. Monitoring for each of the performance criteria will continue until performance criteria are satisfied. If performance criteria are not met, the causes will be investigated and adaptive management actions/corrective measures will be implemented. It is anticipated that some elements of the monitoring program will become part of regional monitoring programs currently in place and developed in the future.

Monitoring components include:

- Inundation regime
- Levee breach geometry
- Sedimentation
- Channel network evolution
- Native marsh vegetation development
- Wildife
    - Avian surveys
    - SMHM surveys
- Fish surveys (pending additional secured funding)
- Water quality
- Methyl mercury
- Erosion of Adjacent Sloughs
- Invasive plant control

The monitoring plan also includes an Adaptive Management component to ensure that the project goals and objectives are met.

Inundation Regime

Inundation regime will be evaluated by collecting the tide stage both inside and outside the property. Evaluation of the tide stage data will inform DWR and the other SMPA ECAT agencies on whether the project is achieving unimpeded tidal exchange, which is a fundamental component of the restoration objectives.

DWR maintains a water quality monitoring station (BLL) along Little Honker Bay/Little Honker Slough as part of the California Data Exchange Center (CDEC) monitoring network (Figure 5). This station measures precipitation, water temperature, wind speed and direction, atmospheric pressure and stage hourly. A pressure transducer was installed on the pond side of the levee to monitor tide stage within the site. Data is telemetered to Sacramento so tide stage can be monitored remotely. Comparing the tide stage inside the site with that of the slough will indicate whether the restoration is achieving unimpeded tidal flow. If tides are unimpeded, then the tide stage inside the site will be nearly identical to that which is measured in the adjacent slough. If tides are constricted, then the tide height inside the sit will be lower than outside; reduced height of high tides inside the site will provide a simple indicator of this problem. If low tides inside the site are higher than that of the adjacent slough, this indicates that the site does not drain effectively.

Levee Breach Geometry

Planned breaches were designed for unimpeded tidal flow at the time of construction. If breaches are constructed as designed, they may erode naturally in the early development stage then it may sediment in as the site's tidal prism decreases with overall sedimentation.

A cross sectional survey will be conducted following construction. The need and timing of additional cross sectional profiles will be dependent upon observed changes of the breach and an evaluation of tidal inundation (see above). Periodic cross sectional profiles may be conducted of the breach to document tidal scour or sedimentation and aid management decisions regarding breach maintenance.

At the unintended breach (52+00 and any future unintended breaches), natural erosion is also expected to occur until equilibrium conditions (stabilized breach size) are achieved. Evolution of an unplanned breach is dependent on the mechanism of the initial levee failure, the size and condition of the levee, and the levee material at the location of the unplanned breach. With an unintended levee failure, it will be imperative to evaluate breach geometry data closely in conjunction with tidal inundation data to assess if restoration goals are being achieved. If goals are not being achieved, adaptive management/corrective measures would likely include modifying the breach or breaching the levee in another location.

Surface Elevation Changes/Sedimentation

To meet the project goals of restoring tidal marsh, sedimentation must occur within the subsided Blacklock property. Naturally deposited sediment aided by accumulation of plant detritus forms the substrate that is essential to plant establishment and growth and it provides the environment required by benthic organisms. The original constructed breach location was selected in part because of its proximity to Little Honker Bay. It is expected that Little Honker Bay will provide a sediment source for the Blacklock restoration site.

Sediment accumulation on the site will be monitored with Sediment Erosion Tables (SET's) installed and periodic topographic surveys. The topographic surveys, at fixed locations will be conducted periodically to assess elevation changes.

Three SET's have been installed throughout the site as shown on Figure 5. The SET's were placed in three distinct habitat types throughout the site. One was placed within emergent vegetation in the southwest area of the parcel, a second was placed in an existing pond, and the third placed in a slightly higher area within a large area of salt grass, near the northeast corner of the parcel.

Vertical accretion of sediments will be measured and compared with baseline data that was collected prior to the breach. The SET (Calhoun et al, 2002) consists of an arm temporarily inserted into a survey rod secured in a concrete filled PVC pipe. Pins are then inserted through a plate on the arm and successive measurements track changes in marsh surface elevation relative to the base of the pipe. A sampling structure was constructed at each SET location prior to inundation to prevent disturbance of the surface where measurements are made. To account for possible settlement of the SETs themselves, which may occur because the weight of the concrete used to install them could cause them to sink in the soft peat soils, the benchmark on each SET was surveyed to a known nearby benchmark at each SET measurement event.

Baseline SET measurements were collected during April 2006 and again in September 2006. Subsequent measurements will occur as soon as is practical after breaching, and at approximately 6 month intervals. USGS established protocol will be followed for reading the SET's. It is expected that SET data will be collected at 6 month intervals, unless sedimentation data indicates that readings should occur more or less frequently. SET data will be collected until elevations stabilize on the site.

In addition to SET measurements, feldspar marker horizons were installed at each SET and cryogenic core samples will be extracted from the feldspar locations. Samples will be extracted at each 10 cm deposition interval

up to 30 cm of deposition as measured by the SET, and at year 10. Data from the SET and feldspar marker horizons together allow for direct measurements of sediment accretion at the site.

Slough Network Evolution

A slough channel network must be available to support the diverse fish and wildlife communities expected to use the restored tidal marsh. In addition, an effective slough network is necessary to maintain the hydrology on site and support tidal exchange throughout the property.

While there is an existing slough network on the site, the location of the breach may result in flows altering the configuration of sloughs within the property and these sloughs are all many feet below marsh plain elevations. Changes in the slough network will be monitored using aerial photography. Parameters to be measured include total surface area of channels, areas of expansion and loss, and changes over time.

Native Marsh Vegetation Development

Vegetation development will be monitored to assess if native tidal marsh vegetation develops consistent with the performance criteria developed for this project. Plant community evolution will be measured a change in percent cover of vegetation classifications over time.

While there is extensive native marsh vegetation currently on the site, it is expected that some of that will die off as a result of inundated conditions. Since the property has been inundated, the saltgrass has been submerged and has died off. The pickleweed areas were also submerged. It is expected that much of the emergent vegetation will survive inundation and continue to colonize throughout the site, including those areas previously dominated by saltgrass and pickleweed. The die off of vegetation as a result of inundation will provide material for substrate formation. It is expected that sedimentation and detritus accumulation will raise site elevations and that vegetation will colonize as land surface elevation increases. Eventually, the vegetation will transition to a mix of species suited to the intertidal brackish environment.

In an effort to maintain consistency with regional data collection programs, the survey methodology established for the Suisun Marsh Vegetation Survey (DFG 1999 and 2003) will be used to measure vegetation changes at the site. This survey, developed by the DFG's Wildlife Habitat Analysis Branch blends ground-based classification, aerial photo interpretation, and GIS editing and processing. The method is based on the development of a quantitative vegetation classification, which is used to describe the vegetation map units of the marsh. Since this survey was initiated, updates to the protocol have been implemented to improve survey accuracy. These updates include adding an additional step to rectify the existing polygons to the new base image and interpret vegetation units utilizing a heads-up digitizing approach. If and when additional updates to the survey are implemented, they will be incorporated in the surveys at Blacklock.

Vegetation monitoring will consist of digital and field examination of ortho-rectified aerial photos. Ground verification at the Blacklock site will be conducted each year the survey is conducted. This ground verification will be expanded beyond that of the marshwide survey to verify the accuracy of the polygon attributes at Blacklock.

Vegetation monitoring is proposed for years 1,3,6,9, and 10. During the years that the tri-annual vegetation survey is being conducted, this monitoring will utilize the aerial surveys and interpretation from the marshwide flight. During monitoring years that the marshwide surveys are not conducted (years 1, 10), aerial photos will be taken in June or July to correspond with the aerial surveys conducted as part of the Suisun Marsh Vegetation

Survey. Evolution will be measured as a change in percent cover of vegetation classifications over time, as described in the Suisun Marsh Vegetation Survey.

Wildlife

DWR anticipates that restoration of Blacklock to tidal marsh will provide long-term ecological benefits to tidally dependent wildlife species. After tidal inundation, it is expected that habitat will be available for waterfowl and shorebirds. However, it is anticipated to take several years of sediment accretion for marsh elevations to raise enough to provide habitat for terrestrial species. Once surface elevations rise, and vegetation colonizes, it is expected that Blacklock will develop into a fully functioning tidal marsh with suitable habitat for marsh dependent wildlife species, including black rails and salt marsh harvest mice. However, it is expected to take several years before extensive suitable habitats develop at Blacklock.

Avian Monitoring

Waterfowl and shorebird uses of the Blacklock restoration will be conducted. These surveys will begin within one year of breaching and will continue quarterly at both low and high tide to track shorebird and waterfowl use of the ponds. Without additional secured funding, agency staff (DWR/DFG/SRCD) will conduct the surveys. With additional secured funding, the avian monitoring program will be expanded and will be conducted by PRBO Conservation Science.

Both tidal-marsh dependent birds, which includes, black rail, song sparrow, common yellowthroat, and marsh wren, will be monitored, as well as other bird groups, mainly waterbird species, that are expected to mainly make use of habitat at this site during the restoration period, either early or late. This site is thought to be too far east to support California clapper rail; therefore, CCR specific surveys will not be conducted.

Some groups of waterbird species are expected to make use of the site during the early period (soon after breaching) and other waterbird species are expected to use the site later during the restoration process (e.g., shorebirds such as avocets and stilts, and waterfowl, such as dabbling ducks; Stralberg et al. 2004).

At Blacklock, two types of surveys will be conducted. Survey methods and protocols are consistent with those described by the Wetlands Regional Monitoring Program (WRMP 2002), and are similar to those used by the IRWM program (www.irwm.org).

The two survey types are:

(1) point count surveys,
(3) black rail surveys.

Point count surveys is a generic method intended to survey all bird species using a site, the second method is specialized surveys intended only for the specified species. Point count surveys are intended to be conducted in all habitats.

Point count surveys: Point count stations (survey observation points) will be established at about 10 locations, both along levees and in the site. For the Blacklock site, point count locations have already been established and survey data has been collected in the past by PRBO. It would be desirable to retain these locations as much as possible. Surveys are conducted 4 times per year.

Black rail surveys: Surveys will be conducted twice per year, in April and May, following standardized procedures (Evens et al. 1991, WRMP 2002). Black rail surveys will be conducted at each point count survey station (see above), for sites with possible rail habitat.

SMHM surveys

With tidal inundation, the Blacklock property is included in the 2500 acres of conservation area designated in Suisun Marsh. This designation is an outcome of SMPA ECAT actions. Therefore, Blacklock will be surveyed for SMHM once every three years as part of the existing SMHM monitoring program for conservation areas in Suisun Marsh.

Habitat on the levees and in the pond will be assessed annually. After tidal inundation of the pond, it is expected that SMHM habitat will be present only on the levees. Recent surveys have captured very few SMHM on the levees. Until suitable habitat begins to develop in the pond, SMHM surveys will be conducted only on the levees. Once habitat begins to develop in the pond, surveys will be conducted in these areas if they can be done in a way that does not adversely affect the developing vegetation. Trapping protocols will be similar to protocol used by DWR and DFG in their existing marsh wide SMHM surveys.

Fish

This element of the monitoring plan would only be implemented if additional funding for fish monitoring is secured. See the section below titled "potential additional funding/monitoring activities for Blacklock restoration project" for details on a proposed fish monitoring program.

Water Quality

Hydrodynamic modeling conducted by DWR has suggested that breaching levees in Suisun has an effect on salinities both in Suisun Marsh and in the Sacramento San Joaquin Delta (see the Draft Restoration Plan for details). The specific effects are dependent on the size and location of the breach and the area of inundation. Modeling of the Blacklock restoration shows changes in salinity in Montezuma Slough, both upstream and downstream of Nurse Slough. These changes were minor and are not expected to impact DWR's ability to meet SWRCB salinity standards for Suisun Marsh. DWR will continue to collect salinity data at the BLL monitoring station adjacent to the restoration. In addition, salinity data is continuously collected and at the other compliance and monitoring stations in Suisun Marsh as part of SWRCB D-1641 requirements.

The BLL monitoring station will be adapted to collect additional water quality parameters. DWR will install instrumentation to collect temperature, EC and dissolved oxygen inside the pond at the same location as tide stage is collected (Figure 5). While this monitoring station is an ideal location to measure tidal inundation, it is not likely not representative of the water quality conditions at the site. Dissolved oxygen levels would be expected to be much lower at this location because it is at the end of the property, with the low circulation potential. EC, DO and temperature will be continuously collected, and data will be telemetered to the CDEC.

Temp, EC and DO may also be collected in other areas of the restoration site as part of any future fish monitoring (pending available additional funding).

Methyl Mercury

Water quality changes, specifically changes in salinity and the production of methyl mercury, resulting from tidal inundation at Blacklock are of particular interest to DWR and other agencies involved in long term planning decisions in Suisun Marsh.

Currently, there is a paucity of methyl mercury data from the Blacklock restoration site. DFG collected water samples during one field event in February, 2005. Very high methyl mercury concentrations (up to 2.3 ng/L) were observed during this sampling event, when water was collected after the levee overtopped and the pond was full. Nurse Slough, the wetland adjoining Blacklock, was observed to have significantly lower methyl mercury concentrations (up to 0.07 ng/L) in water collected July, 2004.

Methyl mercury is produced during bacterial reduction of sulfate in surficial sediments, thus the likely source of methyl mercury to overlying water in Blacklock is flux from the sediments. When the breach occurs water and suspended sediment from in Blacklock will likely be exchanged with water and suspended sediment originating in Nurse Slough/Little Honker Bay. Methyl mercury concentrations in Blacklock could decrease or increase as a result of the breach.

Mark Stephenson, DFG Moss Landing is investigating methyl mercury issues in Suisun Marsh as part of a CALFED funded study and has developed a methyl mercury monitoring program for the Blacklock Restoration Project. The DFG monitoring program proposes the following sampling plans to analyze water, sediment and tissue pre- and post- breach to assess the changes in methyl mercury associated with full tidal inundation at the site.

The pre-breach sampling efforts for water, biota, and sediments were funded under the existing CALFED grant. Since the San Francisco Bay RWQCB is in the process of developing the mercury TMDL, the sampling plan could be revised in the future if standardized protocols are developed to support this effort.

If additional funding is secured (SWRCB grant, directed studies, other grants), this sampling program could be expanded as described in the section below titled “potential additional funding/monitoring activities for Blacklock restoration project”

Hypothesis 1: Sediment concentrations in Blacklock will decrease post breach relative to pre breach concentrations.

Proposed Sampling Plan - Measure total and methyl mercury in sediments at 10 sites in Blacklock before the breach then at 6, and 12 months post breach. Sample mercury, methyl mercury, grain size and organic carbon at specific depths (0-5). Sampling will be based on a stratified random design that stratifies according to elevation, sediment and vegetation type.

Hypothesis 2: Methyl mercury in biota will decrease in Blacklock post breach.

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Proposed Sampling Plan - Sample resident fish species in Blacklock and Nurse Slough pre- breach and 12 months post- breach.

Hypothesis 3: Blacklock is a source of mercury (water samples)

Proposed Sampling Plan - Methyl and total mercury will be measured at 6 locations throughout the Blacklock property and 3 locations in the Nurse/Denverton/Little Honker Bay vicinity. Grab samples will be collected pre breach and 1, 3, 6, and 12 months post breach. Samples will be analyzed for total and methyl mercury and TSS.

Erosion of Adjacent Sloughs

Pre-breach bathymetry surveys were conducted in September 2006 at both the Little Honker Bay and Arnold Slough proposed breach locations (Figure 2). A post breach survey will be conduced in Little Honker Bay approximately 1-3 months post breach to evaluate erosion of the channel sediments near the breach location. It is expected that a scour of the bottom sediment adjacent to the breaches will occur as the sediment moves into the restored wetland. If a second breach is constructed in Arnold Slough, pre –and post- breach bathymetric surveys would be conducted.

Control of Invasive Plant Species

Colonization of the Blacklock restoration site by non-native invasive plant species would jeopardize meeting the objectives of the restoration. Many of the important ecological benefits of restored tidal marsh vegetation will not be provided by invasive species. Specifically, colonization by invasive non-native plant species may prevent establishment of native tidal marsh vegetation.

Monitoring and control of non-native invasive plant species will focus on two invasive plants that are particularly problematic in Suisun-*Phragmites australis* and perennial pepperweed (*Lepidium latifolum*). Lepidium is a problem throughout Suisun marsh, however, it has not been found at Blacklock to date. When and if pepperweed is found on the site, control methods, including herbicide use, may be employed to prevent its establishment at the site. DWR staff will consult with weed management specialists to identify the most appropriate control method.

Annual surveys for non-native invasive plant species will be conducted. In addition, field personnel will be encouraged to report any occurrences of pepperweed to weed control specialists for immediate treatment, if appropriate. DFG has initiated a pilot program to use Chlorsulfuron (Telar) in tidally influenced areas. The Although Telar is approved for use in tidally influenced areas only above the Mean High Tide line, the DFG study applied Telar (1% and 2 %) in areas where the area above the Mean High Tide line would not be inundated for at least 24 hours. Those times usually occurred in May and September. The May spraying coincided with the plants being in the bud stage which has been shown to be one of the most effective times to spray. DFG reported that the 1% solution to be almost as effective as the 2%, but because of the difficulty of access to the sites they used 2% to make sure they maximized the effectiveness of the spray effort. (Sarah Estrella, DFG, pers com, 7-24-2006)

The spread of phragmites is a problem throughout Suisun Marsh and control experiments are ongoing. As in other managed wetlands, populations of phragmites have become established at Blacklock. The depth and duration of flooding with tidal inundation may help control the spread of this species (FWS, 1989). Monitoring will be conducted annually to determine any changes in phragmites cover. Alternative treatment techniques may be employed to control the spread of this species, if needed.

Adaptive Management

Adaptive management means taking informed, intentional actions designed to achieve pre-defined goals and objectives, observing the effects of those actions over a prescribed time period, evaluating the observed outcomes of those actions against a set of pre-defined criteria, and determining whether further actions should be

taken based on those evaluations (Lee, 1993). In this adaptive management framework, it is critical to consider up-front what range of *feasible* actions could be taken, so that monitoring and decision making are focused on elements where intervention is possible and likely to have a measurable effect.

Whether tidal inundation occurs at Blacklock under a planned or unplanned event, adaptive management will be incorporated, as needed, to meet project goals and objectives. Physical and biological parameters will be monitored to evaluate success in meeting desired outcomes and to minimize undesirable outcomes. Physical parameters including tidal regime and breach geometry will be used as an indicator for future actions. Monitoring these physical parameters, in addition to possibly using the computer model as a predictive tool, will inform project planners on specific actions that might be implemented. Adaptive management will be incorporated, as needed and practical, to meet the goal of providing suitable habitat for native species.

Because the existing conditions of the exterior levees suggested that levee failure would occur in some location other than our preferred breach location, deepening or widening of the breach may be required to achieve full, unimpeded tidal flow. As described in the Draft Restoration Plan, the JARPA permit application, and the CEQA/NEPA documentation, site conditions will be monitored and observed to allow time for evolution of the breach.

The Adaptive Management Program for the Blacklock Restoration Project consists of the following elements:

- Milestone #1: At one year following breach (whether planned or unintentional), results of several monitoring parameters will be evaluated to determine whether any further actions are needed: the degree of tidal inundation, amount of sedimentation, breach geometry evolution, vegetation community changes, mosquito production, and invasive species colonization. These data will inform whether levee breaches need to be enlarged, new levee breaches added, or invasive vegetation control needed.

- Milestone #2: At three years following implementation of any changes following review at Milestone #1, results of the same parameters will be evaluated. These data will inform whether any final measures are warranted to alter the course of the site development to promote meeting its goals and objectives.

- Monitoring data review: In between and following these two milestones, monitoring data will be reviewed along with site observations made during monitoring, for early detection of desired or undesirable outcomes. If these reviews indicate clear adverse conditions prior to reaching either milestone, actions under those milestones would be moved forward as deemed appropriate by DWR, its Advisory Team and the Suisun Marsh Preservation Agreement (SMPA) Coordinators.

Monitoring Reports

Monitoring reports describing the data collected and any adaptive management actions will be submitted to BCDC every two years, beginning on December 1, two years following the completion of restoration activities. Monitoring reports will be available on-line at http://iep.water.ca.gov/suisun/restoration/blacklock/ Regular updates on project implementation and monitoring will continue to be presented at Suisun Marsh Preservation Agreement Environmental Coordination Advisory Team meetings.

Survey Methodology and Quality Assurance/Quality Control

All data collection and analysis will follow Interagency Ecological Program QA/QC requirements (IEP 1999) unless otherwise specified in this document. .

POTENTIAL ADDITIONAL FUNDING/MONITORING ACTIVITIES FOR BLACKLOCK RESTORATION PROJECT

In addition to the monitoring being conducted as part of this monitoring plan, other monitoring and research efforts may be conducted within the project area and vicinity. These other monitoring and research efforts are important to the project because they will provide additional information on the performance and evolution of the project and its effects on the surrounding areas. Our goal is to coordinate sampling activities so that potentially related information is collected that data sets can be correlated. In addition, monitoring will be coordinated, to the extend possible, with other restoration projects proposed for Suisun Marsh, including Hill Slough West, Miens Landing and others.

SWRCB Consolodated Grants Proposal

In an attempt to increase understanding of tidal marsh responses and strategies, including how restored tidal marshes will evolve, on what time frame, with what design techniques and construction approaches (including Best Management Practices) are most effective, and how they contribute to methyl mercury production, the Association of Bay Area Governments (ABAG) submitted a proposal as part of the 2006 State Water Resources Control Board Consolidated Grants solicitation to secure more funding for a comprehensive monitoring and assessment program at the Blacklock Restoration Project. This proposal, *Blacklock Tidal Marsh Restoration Demonstration Project Lessons Learned,* expands on the components of the monitoring plan submitted here, and identifies funding for USGS, DFG, PRBO Conservation Science, and Wetlands and Water Resources to assist in monitoring activities. A total of $620,000 was requested. A decision on funding is expected in September /October 2006. If the proposal is accepted, funds are expected to be available early 2007 for a three year contract term.

Fish

Desired outcomes of the restoration of Blacklock to tidal marsh are to provide habitat for native fishes and aid in the recovery of listed fish species in Suisun Marsh. However, in a review of information regarding native fish use of restored freshwater tidal wetlands, Brown (2003) concluded that restoring tidal wetlands may not provide as great a benefit to native fish populations as originally expected. Studies of tidal marsh restoration sites in the Delta have found statistically higher density of native fish at reference sites as compared to the restored sites (Simensted et al. 2000). This suggests that the restored sites do not provide the same habitat value as the historic tidal wetland. Similar studies conducted for BREACH at sites in Suisun Marsh do indicate potential for native fishes benefits (Simenstad, unpublished data). Further, Dr. Peter Moyle of UC Davis, who has conducted more than 25 years of fish monitoring in Suisun Marsh, has stated his belief that tidal marsh restoration in Suisun Marsh could provide important benefits to native fishes (CALFED Science Conference, 2004).

Following breaching of the site it will likely take several decades for the restored wetland to develop and mature. During this period the marsh will shift from allochthonous (outside) to autochthonous (within) biotic production. This shift will affect the ability of the habitat to provide adequate food-chain support. Threatened and endangered fishes of the upper San Francisco Estuary, including Suisun Marsh, are winter-run and spring-run Chinook salmon, steelhead, green sturgeon, and delta smelt. These species do not extensively use small marsh channel

habitats like those in the Blacklock site (Matern et al. 2002). However, there is considerable evidence of food limitation for upper San Francisco Estuary fishes (Sommer et al. 2001; Kimmerer 2002; Nobriga 2002; Feyrer et al. 2003; Bennett 2005). Thus, marsh restoration projects that contribute lower trophic level productivity to the estuary can be expected to indirectly benefit some or all of the listed fishes. The goal of the fisheries monitoring is to assess the change in habitat value of the Blacklock restoration site for native fishes over time. Specifically, how do fish support functions (phytoplankton production, invertebrate composition and abundance, vegetation, tidal hydrology, etc.) vary between Blacklock and a reference site?

Monitoring will begin two years after the initial levee breach and continue on a triennial basis. This will allow time for the site to adjust to the changed conditions and begin the shift from external to internal production. This monitoring will include an assessment of fish occurrence and abundance; phytoplankton production and invertebrate composition; and abundance and flux of lower food web production outside the restored site. At a minimum, samples will be collected once a month during April and May.

Fish assemblage sampling will be conducted with fyke nets and/or beach seines, depending on location at the site. Fyke nets will be deployed in the channel(s) at high tide and fish will be collected during the ebb tide. A flowmeter will be attached at the mouth of the fyke net to measure volume sampled. Larger ponded areas may be sampled using a beach seine.

Contents of each seine or fyke will be placed into large containers of water. When possible, fish equal to or greater than 20 mm total length (TL) or fork length (FL) will be identified to species on site. Up to 20 randomly selected individuals of each species from each sample will be measured to TL or FL if the caudal fin is forked. When more than 20 individuals of a species are present in a sample, the remaining individuals will be tallied, but not measured. Fish that cannot be identified on site will be preserved in 10% formalin and identified in the laboratory. For each site the tidal stage, temperature, salinity, specific conductance, water transparency, and dissolved oxygen will be recorded.

Zooplankton will be collected with pump samplers deployed from shore inside and outside the restored and reference sites. Samples will be preserved in formalin on-site and sent to the laboratory for enumeration and identification of species and life stages. Water samples for phytoplankton will be stored at 4°C and filtered within 2 hours onto GF/F glass fiber filters. Filters for chlorophyll a analysis will be treated with magnesium carbonate as a preservative and frozen until laboratory analysis.

Monitoring frequency and duration will be determined by available funding. Blacklock has been identified as a project in the POD Action Plan, which may provide additional funding for monitoring.

A secondary element to the fish monitoring program would be the inclusion of monitoring fish occurrence and abundance. Blacklock has been identified as a project in the POD Action Plan, which may provide funding for monitoring.

Sacramento Perch Reintroduction

In an effort to re-establish Sacramento perch in its native range, Dr. Peter Moyle from UC Davis is working in conjunction with eh Contra Costa Mosquito and Vector Control District (CCMVCD) and DFG to re-introduce Sacramento perch at key locations. The Blacklock Restoration Site has been identified as a location that could support re-introduced populations of Sacramento perch.

Approximately 300 juvenile Sacramento perch were obtained from CCMVCD's hatchery and released at two locations at Blacklock on September 13, 2006.

Avian Monitoring

Waterfowl and shorebird uses of the Blacklock restoration using standard protocols (Point Reyes Bird Observatory protocols for monitoring birds in tidal marsh as described in Nur 2005) will be conducted. These surveys will begin within one year of breaching and will continue quarterly at both low and high tide to track shorebird and waterfowl use of the ponds. Non threatened and endangered bird species monitoring will end five years after breaching. With secured funding, bird surveys will be conducted by PRBO Conservation Science. Without additional secured funding, agency staff (DWR/DFG/SRCD) will conduct the surveys.

Monitoring physical and biological evolution at the breached site, with comparison to other comparable sites, will help agencies and stakeholders determine the extent to which the restoration plan and site management are achieving the desired outcomes or targets. In addition, collection and analysis of data are required to inform adaptive management decisions. More broadly, information gathered from the Blacklock Restoration Project can be used in the future to plan and evaluate other tidal marsh restoration sites throughout Suisun Bay. Finally, specific information gathered as part of this project will contribute to Bay-wide monitoring programs (Wetlands Regional Monitoring Program [www.wrmp.org], the Integrated Regional Wetlands Monitoring Program [www.irwm.org], and the newly developed Comprehensive Monitoring Assessment and Research Program 3 [CMARP] of the California Bay-Delta Authority). Therefore, it is important that monitoring data be collected in standardized and compatible manner, both with respect to parameters monitored and the specific protocols.

Both tidal-marsh dependent birds, which includes, black rail, song sparrow, common yellowthroat, and marsh wren, will be monitored, as well as other bird groups, mainly waterbird species, that are expected to mainly make use habitat at this site during the restoration period, either early or late. This site is thought to be too far east to support California clapper rail; therefore, CCR specific surveys will not be conducted.

Some groups of waterbird species are expected to make use of the site during the early period (soon after breaching) and other waterbird species are expected to use the site later during the restoration process (e.g., shorebirds such as avocets and stilts, and waterfowl, such as dabbling ducks; Stralberg et al. 2004).

Monitoring will be conducted at the Blacklock Restoration site, as well as at adjacent marsh nearby, “Overlook” marsh. In addition, avian monitoring will be conducted at at least one additional mature tidal marsh (“reference” site), such as Rush Ranch, and at one site being managed for waterbirds that is not slated for restoration, such as Delta King. Thus, avian monitoring will be conducted at four sites in total.

Three of the sites listed (Blacklock, Overlook, and Delta King) were monitored by PRBO Conservation Science (PRBO) biologists for a full 12 month period in 2004-2005, in three seasons: fall, winter, and breeding season (March to May). The fourth site, Rush Ranch, has been monitored in the breeding season by PRBO biologists every year since 1996, and additionally during the fall and winter in 2001-2003 as part of the BREACH 2 (Breached Levee) study. The surveys referred to above were general avian surveys covering all groups of birds; in addition, specialized surveys have been conducted for black rails and clapper rails in recent years.

At these sites, three types of surveys will be conducted. Survey methods and protocols are consistent with those described by the Wetlands Regional Monitoring Program (WRMP 2002), and are similar to those used by the IRWM program (www.irwm.org).

The three survey types are:

(1) line transects (also referred to as area surveys),
(2) point count surveys,
(3) black rail surveys.

The first two are generic methods intended to survey all bird species using a site, the two survey method is specialized surveys intended only for the specified species. Of the two general survey methods, line transects can only be conducted in relatively open habitat (no vegetation or low vegetation). Point count surveys are intended to be conducted in all habitats. Line transects are the best means to survey waterbirds (including shorebirds, waterfowl, herons, egrets, gulls, and terns), while point count surveys provide the best means to assess passerines and other landbirds. Line transects provide information on habitat use (activity of birds detected during a survey), but point count surveys do not. Thus, pairing these two survey methods (to the extent possible) yields the best possible data.

Line transects: surveys will be conducted during the breeding season (twice), fall (once), and winter (once). The early spring survey will take place during the migratory period for waterbirds. A transect route (which usually consists of several line segments) is laid out, such that it provides representative coverage of the site, as much as possible. The total transect route is between 500 and 2000 meters per site; the width of the survey area along the transect is up to 200 meters and can be on just one side of the route or both sides. To standardize effort, one survey "unit" is approximately a 1 km transect surveyed in a period of 1 hour. Depending on size, each marsh will have 0.5- 2 units. Each transect will be walked once during the survey period.

Surveys are conducted both at high tide and low tide, if possible during the same day. A total of eight surveys are conducted per year (four times per year for low tide and the same number for high tide). The survey period is approximately one hour per site, or until the entire site (transect) is covered, usually before the tide starts to change. Birds are observed with binoculars and a spotting scope and behavior and habitat type are recorded. Behaviors are classified as foraging, hovering (feeding or looking for food from the air as with raptors and swallows), roosting, locomoting (walking or swimming), flying over, flying into, flushing out, and other. Habitat types included channel (in the water or at the edge), mudflat, marsh vegetation, levee, man-made (e.g., wooden posts) and general marsh/unknown (usually used with hovering or flushing birds). All birds are recorded with respect to species and location is noted on a map, which allows estimation of distance from the observer. Birds flying over, obviously on their way to another destination, are excluded. Also recorded are time (for tide height calculation) and weather conditions (wind speed and direction, temperature, cloud cover, rainfall conditions).

Point count surveys: This method has been widely used to survey landbirds, including marsh birds (Ralph et al. 1995; Nur et al. 1997). Point count stations (survey observation points) will be established at about 10 locations in each site (depending on area of site), both along levees and in the site. For all sites, point count locations have already been established and survey data has been collected in the past by PRBO. It would be desirable to retain these locations as much a s possible. Point count stations are spaced at least 200 m apart, to minimize the chance of counting birds at more than one point. Surveys are conducted starting within 15 min of sunrise and completed before songbird activity decreases around 10 am. Surveys are not conducted at a particular stage of the tidal cycle. Surveys are conducted 4 times per year (early breeding season, late breeding season, fall, and winter). Surveys are not conducted during adverse weather conditions (rain or strong wind). At each point, an

observer records all birds detected by sight and sound, identified to species, during a 5-minute period. Distances to the detected bird and detection type (whether visual, by song, or by other auditory means) are also recorded. Birds detected outside the target site in adjacent tidal marsh or agricultural fields are recorded as such. Birds flying over the site are also noted. These are considered to not be using the site except for raptors and swallows which usually search for food in flight. Also recorded are time (for tide height calculation) and weather conditions (wind speed and direction, temperature, cloud cover, rainfall conditions).

Black rail surveys: These surveys will be conducted twice per year, in April and May, following standardized procedures (Evens et al. 1991, WRMP 2002). Black rail surveys will be conducted at each point count survey station (see above), for sites with possible rail habitat. At each station, the observer plays tape-recorded Black Rail vocalizations and waits for a response from nearby rails. The surveys follow a standardized protocol: one minute of silence, 1 minute of taped "grrr" calls, 0.5 minute of "ki-ki-krr" calls and 3.5 minutes of silence for a total of 6 minutes per survey point. All rails detected during and outside the survey window are recorded, along with distance, direction, and vocalization type. All detections will be noted, but the emphasis will be on detections within 50 m of the observer (few birds will be detected beyond this distance, Nur et al. 1997, Spear et al. 1999).

Methyl Mercury

Wetlands are known to be areas of high methyl mercury production (Heim et al 2003, Davis et al 2003, Weiner et al 2003, Marvin De-Pasquale et al 2003). The factors that influence methyl mercury production are numerous and not well understood. However, there are three key factors that appear to be critical to net methyl mercury production. These factors include total mercury concentration, speciation of the mercury, and level of activity of methylating bacteria. Intertidal vegetated wetlands have been found to have significantly greater potential to methylate mercury than adjacent channels, mudflats, or open water (Marvin-DiPasquale et al 2003). While tidal wetland areas in Suisun Marsh and the Delta have been shown to be high producers of methyl mercury, production of methyl mercury in the managed seasonal marshes has not been well documented.

Currently, there is a paucity of methyl mercury data from the Blacklock restoration site. DFG collected water samples during one field event in February, 2005. Very high methyl mercury concentrations (up to 2.3 ng/L) were observed during this sampling event, when water was collected after the levee overtopped and the pond was full. Nurse Slough, the wetland adjoining Blacklock, was observed to have significantly lower methyl mercury concentrations (up to 0.07 ng/L) in water collected July, 2004.

Methyl mercury is produced during bacterial reduction of sulfate in surficial sediments, thus the likely source of methyl mercury to overlying water in Blacklock is flux from the sediments. When the breach occurs water and suspended sediment from in Blacklock will likely be exchanged with water and suspended sediment originating in Nurse Slough/Little Honker Bay. Methyl mercury concentrations in Blacklock could decrease or increase as a result of the breach.

Mark Stephenson, DFG Moss Landing is investigating methyl mercury issues in Suisun Marsh as part of a CALFED funded study and has developed a methyl mercury monitoring program for the Blacklock Restoration Project. The DFG monitoring program proposes the following sampling plans to analyze water, sediment and tissue pre- and post- breach to assess the changes in methyl mercury associated with full tidal inundation at the site. The extent of monitoring on site is dependent on securing additional funding. For example, if the SWRCB proposal is funded, the entire proposed sampling plan could be implemented. If not, a more limited survey monitoring program will be implemented.

Hypothesis 1: Sediment concentrations in Blacklock will decrease post breach relative to pre breach concentrations.

Proposed Sampling Plan - Measure total and methyl mercury in sediments at 10 sites in Blacklock before the breach then at 6, and 12 months post breach. Sample mercury, methyl mercury, grain size and organic carbon at specific depths (0-1, 1-3, and 3-20 cm). Sampling will be based on a stratified random design that stratifies according to elevation, sediment and vegetation type.

Hypothesis 2: Methyl mercury in biota will decrease in Blacklock post breach.

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Proposed Sampling Plan - Sample three species of fish in Blacklock and Nurse Slough pre- breach and 12 months post- breach. Measure mercury in 10 individuals per species during each sampling.

Hypothesis 3: Blacklock is a source of mercury.

Proposed Sampling Plan - Methyl and total mercury will be measured at the breach site over 25 hour periods to estimate mercury mass export/imports during a complete tidal cycle. Twenty samples will be collected during the 25 hour period and measured for total and methyl mercury and TSS. The data generated will be used to predict the amount of methyl mercury that is exported/imported from Blacklock after the breach.

Study option 1-- study will be conducted pre breach and at 1, 3, 6 and 12 months post breach.
Study option 2.-- study will be conducted pre breach and every two weeks for one year.

Hypothesis 4: There are high concentrations of total mercury in deeper sediments

Proposed Sampling Plan - Surveys in Suisun Bay have found that deeper sediments have concentrations of total mercury twice as high (1.0 ppm Hg) than surface sediments (.5 ppm Hg). Mercury will be measured in sediment in 3 cores every 2 to 5 cm in depth. We expect to core to 100 cm. This study will be conducted just after post breach.

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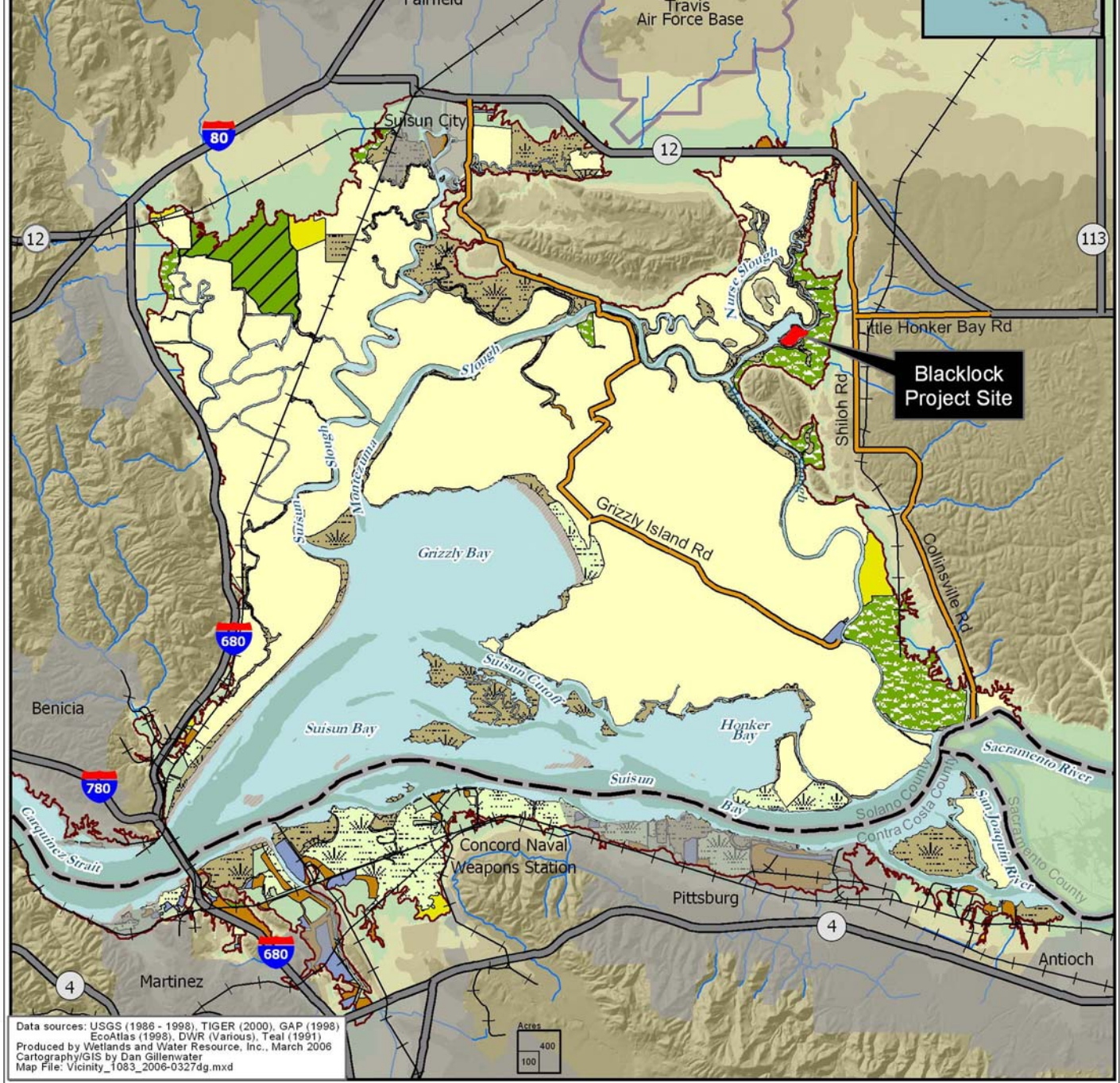
Table 1 - Restoration Monitoring Schedule

Description	Year(s) for Each Monitoring Activity 1	Frequency During Years Monitored	Seasonal Timing
Inundation regime	Years 1, 2, 3, 5, 10	Continuous	Spring Tides (Jun - Jul or Dec - Jan)
Levee breach and outboard marsh channel geometry[3]	immediately post breach (years 3,6,10 as needed)	TBD	TBD
Channel Bathymetry	pre breach 1-3 months post breach	TBD	TBD
Substrate development		Semiannual	winter, summer
SET measurements	annual	two times per year	TBD
cryogenic core samples	after 10 cm accretion (estimating 3 times in 10 year period)	one sample per SET	TBD
Topographic Surveys	Years 1,3,6,10	Annual	TBD
aerial photography/interpretation	Years 1,2,3,6,9,10 (after year 3 scheduled to correspond to suisun marsh vegetation survey)	Annual	summer
Channel network evolution	Years 1, 2, 3, 6, 10	Annual	With air photo and topographic surveys
Vegetation Development (aerial photo interpretation and ground truthing)	Years 1,3,6,9,10	Annual	June-July
Invasive plant species establishment	Year 1 to 75% native veg. cover	annual plus spot checks	summer
Water Quality (temp, EC, DO)	1,2,3,5,10	Continuous at BLLmonitoring station (inside)	
Water Quality (DO)	Baseline sampling prior to breach	pre-breach	discrete locations on site
Methyl mercury -sediment	Baseline sampling prior to breach Begin at inundation	pre-breach 6, 12 months post - breach	TBD
Methyl mercury biota	baseline Year 1	pre -breach 12 months post breach	TBD
Water Quality grab samples	pre -breach 1,3, 6, 12 months post breach	6 samples on site 3 samples outside	TBD
Fish Site Function	(pending a secure funding source)	TBD	April -May
Wildlife use (SMHM)	Survey available habitats	every three years	Jun - Aug
Wildlife use (shorebirds & waterfowl, other species)	Years 1, 2,3, 5, 6 ,8 10	quarterly	winter, spring, summer, fall
Wildlife use (black rail specific)	Years 1, 2,3, 5, 6 ,8 10	two times per year	spring, fall

Table 2- Estimated Cost of Monitoring Plan Implementation

Monitoring Element		Pre-Construction/ Construction (Baseline) 2006-07	Cost	Year 1 2007-2008	Cost	Year 2 2008-2009	Cost	Year 3 2009-2010	Cost	Year 4 2010-2011	Cost	Year 5 2011-2012	Cost	Year 6 2012-2013	Cost	Year 7 2013-2014	Cost	Year 8 2014-2015	Cost	Year 9 2015-2016	Cost	Year 10 2016-2017	Cost	Total by Item
GENERAL																								
Project Management and Reporting	Task	Quarterly CALFED updates. Environmental Document/Permit/Restoration/ Monitoring Plan development	$20,000.00	Project Mgmt and Coordination, Contract Mgmt; ECAT updates	$20,000.00	ECAT updates, Monitoring Report, Project Mgmt and Coordination; Contract Management	$20,000.00	Project Mgmt and Coordination, Contract Mgmt; ECAT updates	$20,000.00	ECAT updates, Monitoring Report, Project Mgmt and Coordination; Contract Management	$20,000.00	Project Mgmt and Coordination, Contract Mgmt; ECAT updates	$20,000.00	ECAT updates, Monitoring Report, Project Mgmt and Coordination; Contract Management	$20,000.00	Project Mgmt and Coordination, Contract Mgmt; ECAT updates	$20,000.00	ECAT updates, Monitoring Report, Project Mgmt and Coordination; Contract Management	$20,000.00	Project Mgmt and Coordination, Contract Mgmt; ECAT updates	$20,000.00	ECAT updates, Monitoring Report, Project Mgmt and Coordination; Contract Management	$20,000.00	$220,000.00
		Funded with:SMPA Phase C matching funds																						
Monitoring Element																								
Inundation Regime	Labor	Installation of BLL station, stage recorder, staff gauge, WQ equipment		Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	Continuous monitoring. Downloading of data; O&M for station and equipment.	$2,500.00	$22,500.00
		Funded with SMPA as part of DWR monitoring network, Phase C funds	$5,000.00																					$5,000.00
water quality monitoring (DO, EC, temp)	Equipment and Expenses	WQ measurement equipt, Staff gauge	$15,000.00																					$15,000.00
Levee Breach Geometry	Task	Survey Breach, verify elevations of material placed in ditch	$5,000.00			survey breach If needed	$5,000.00					survey breach if needed	$5,000.00									survey breach if needed	$5,000.00	$20,000.00
Erosion of Adjacent Sloughs		Bathymethry Survey in Little Honker Bay and Arnold Slough	$11,000.00	post breach bathymetry surveys	$20,000.00																			$31,000.00
Mercury (sediment, water , biota)		survey water, biota, sediment inside Blacklock		sample sediments 10 sites 6, 12 months post breach	$50,000.00																			$50,000.00
		Pre-breach surveys funded with CALFED Comperehensive Mercury Study		sample resident fish species in Blacklock 12 months post breach	$20,000.00																			$20,000.00
				Sample water in blacklock (6 locations) and vicinity (3 locations) 1,3,6,12 months post	$16,000.00																			
SET measurements		Install SET's Baseline Survey		SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	SET Readings 2 times/year	$2,000.00	$18,000.00
cryogenic core samples								cryogenic core samples	$5,000.00							cryogenic core samples	$5,000.00					cryogenic core samples	$5,000.00	$15,000.00
Topographic Surveys				collect topographic survey data	$15,000.00			collect topographic survey data	$15,000.00					collect topographic survey data	$15,000.00							collect topographic survey data	$15,000.00	$60,000.00
Aerial Photography				Shoot Aerials/orthrectify/create mosaic	$5,500.00	Shoot Aerials/orthrectify/create mosaic	$5,500.00	use marshwide veg survey	$1,500.00					use marshwide veg survey expand ground verification	$1,500.00					use marshwide veg survey expand ground verification	$1,500.00	Shoot Aerials/orthrectify/create mosaic	$5,500.00	$21,000.00
Channel Network Evolution				air photo interpretation for slough evolution	$1,500.00	air photo interpretation for slough evolution	$1,500.00	air photo interpretation for slough evolution	$1,500.00					air photo interpretation for slough evolution	$1,500.00							air photo interpretation for slough evolution	$1,500.00	$7,500.00
Vegetation Development		field verification	$1,500.00	interpretation; Field Verification	$1,500.00			use marshwide veg survey expand ground verification	$1,500.00					use marshwide veg survey expand ground verification	$1,500.00					use marshwide veg survey expand ground verification	$1,500.00	vegetation interpretation; ground verification	$2,000.00	$9,500.00
Invasive Species*		inspection	$1,000.00	inspection	$1,000.00	invasive species inspection and control if needed	$5,000.00	inspection	$1,000.00	invasive species inspection and control if needed	$10,000.00	inspection	$1,000.00	inspection	$1,000.00	invasive species inspection and control if needed	$10,000.00	inspection	$1,000.00	inspection	$1,000.00	invasive species control if needed	$10,000.00	$41,000.00
Avian Monitoring				Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00	Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00	Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00			Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00	Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00			Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00			Point counts (quarterly); high and low tide Black rail survey (2X)	$7,000.00	$42,000.00
SMHM Monitoring		Protocol development; Pre-construction Surveys	$5,000.00	assess habitat***		assess habitat		Conduct SMHM Survey on available habitat	$4,000.00	assess habitat		assess habitat		Conduct SMHM Survey on available habitat	$4,000.00	assess habitat		assess habitat		Conduct SMHM Survey on available habitat	$4,000.00	assess habitat		$12,000.00
Annual Costs			$63,500.00		$162,000.00		$48,500.00		$61,000.00		$34,500.00		$37,500.00		$56,000.00		$39,500.00		$32,500.00		$32,500.00		$75,500.00	$643,000.00
15 % contingency**			$9,525.00		$24,300.00		$7,275.00		$9,150.00		$5,175.00		$5,625.00		$8,400.00		$5,925.00		$4,875.00		$4,875.00		$11,325.00	$96,450.00
Total w/Contingency			$73,025.00		$186,300.00		$55,775.00		$70,150.00		$39,675.00		$43,125.00		$64,400.00		$45,425.00		$37,375.00		$37,375.00		$86,825.00	**$739,450.00**
Charges to other funding sources identified but not included in table							$385,250.00																	
* Estimates for Invasive Species control hightly variable and difficult to estimate for long term planning																			$354,200.00					
** To take into account 10 year projections, a 15 percent contingency is included.																			140000					
*** habitat assessment can be done while out at site for during other monitoring tasks																			$214,200.00					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Air Force Base
Fairfield
Suisun City
80
12
113
Blacklock
Project Site
Shiloh Rd
Collinsville Rd
Grizzly Island Rd
Grizzly Bay
Suisun Slough
Montezuma Slough
Nurse Slough
Suisun Cutoff
Suisun Bay
Honker Bay
Suisun Bay
Benicia
680
780
Carquinez Strait
Concord Naval
Weapons Station
Pittsburg
Antioch
Martinez
4
Sacramento River
San Joaquin River
Solano County
Contra Costa County
Sacramento County
Data sources: USGS (1986 - 1998), TIGER (2000), GAP (1998)
EcoAtlas (1998), DWR (Various), Teal (1991)
Produced by Wetlands and Water Resource, Inc., March 2006
Cartography/GIS by Dan Gillenwater
Map File: Vicinity_1083_2006-0327dg.mxd
Acres
400
100
Reference Features
Streets
Elevation (NGVD feet)
> 20
Bayland Habitat Types
Managed Marsh
N

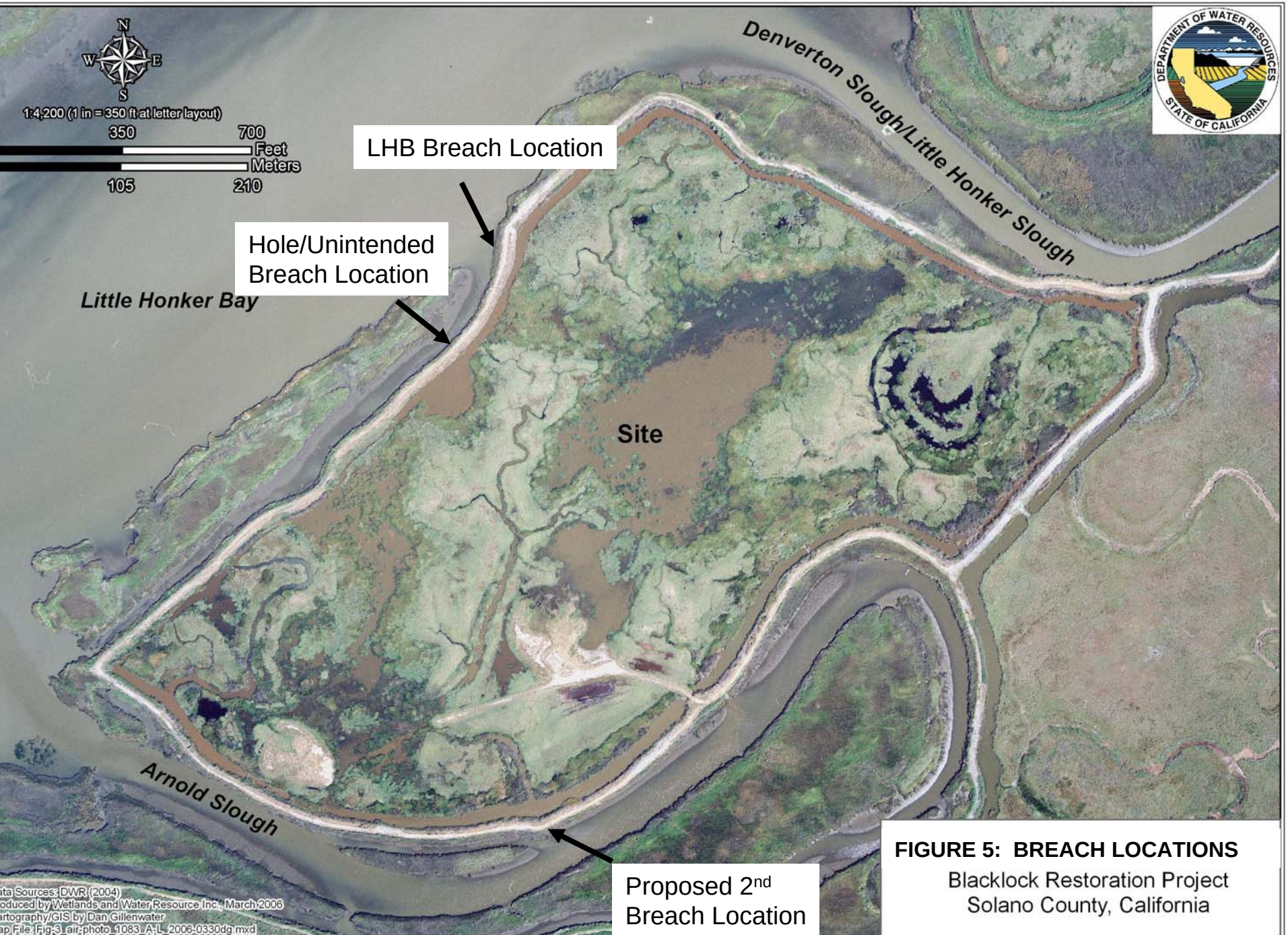

FIGURE 5: BREACH LOCATIONS

Blacklock Restoration Project
Solano County, California

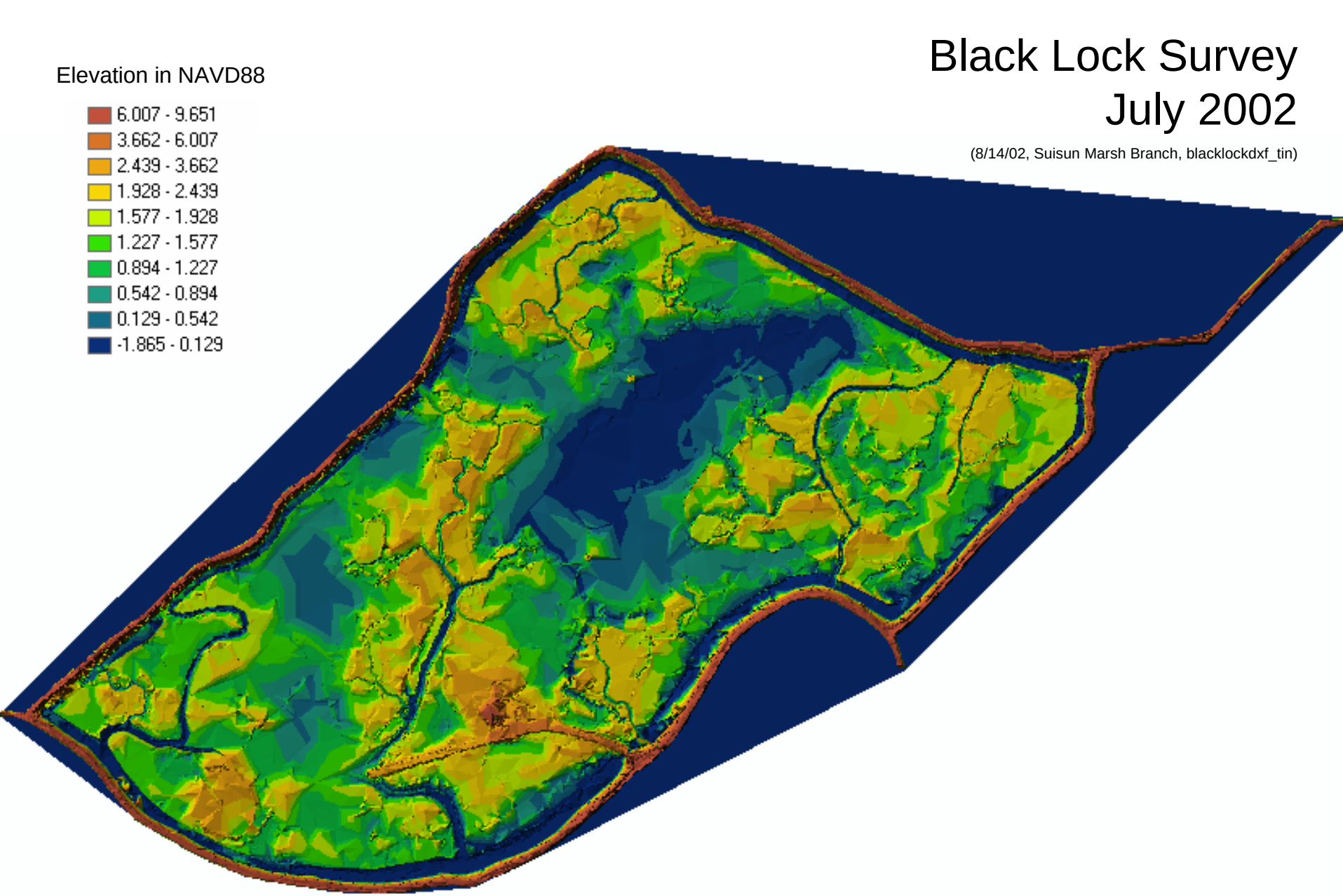

Figure 3. Elevation Survey Detail

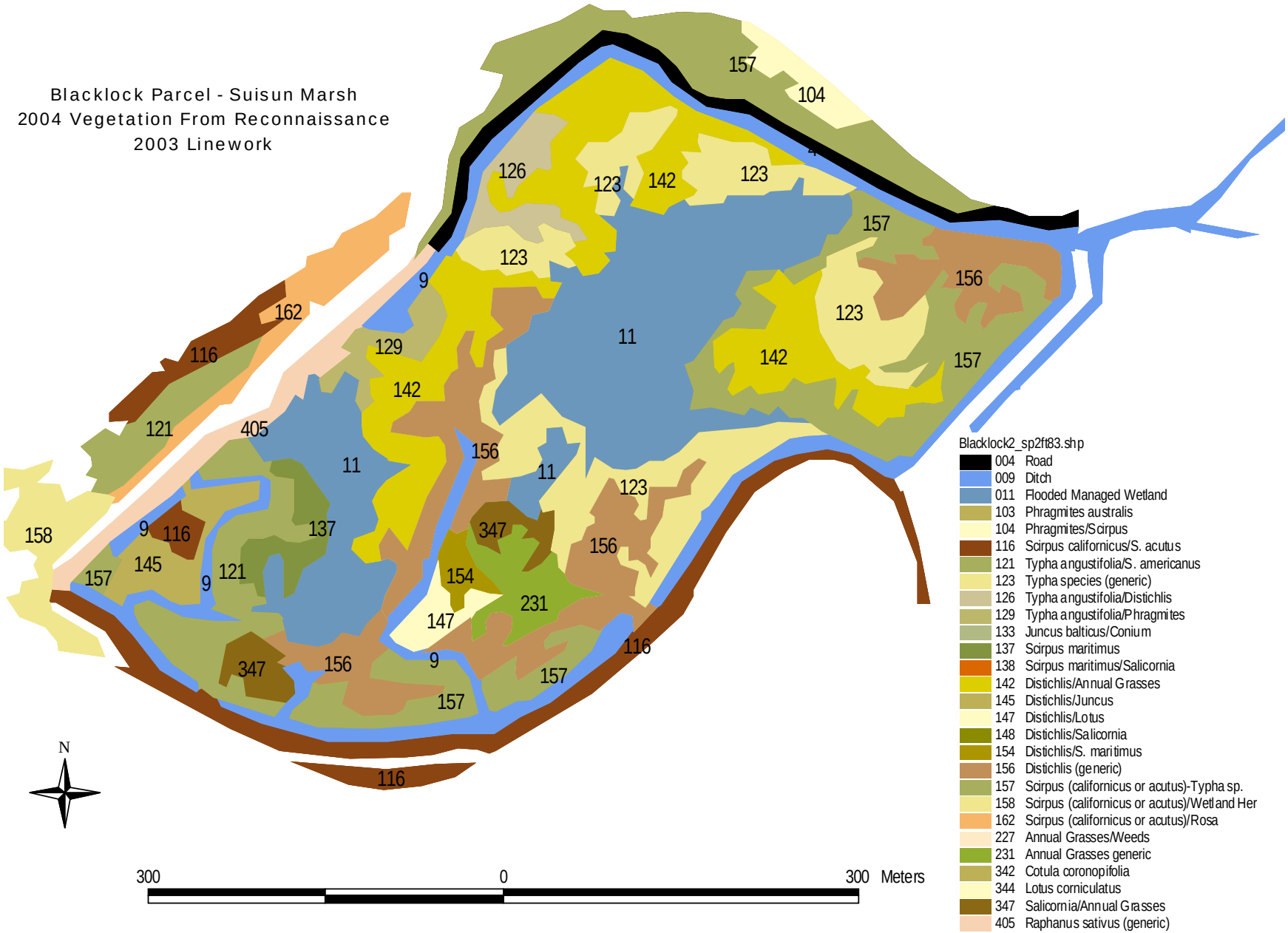

Figure 4: Blacklock Vegetation from 2003 Survey

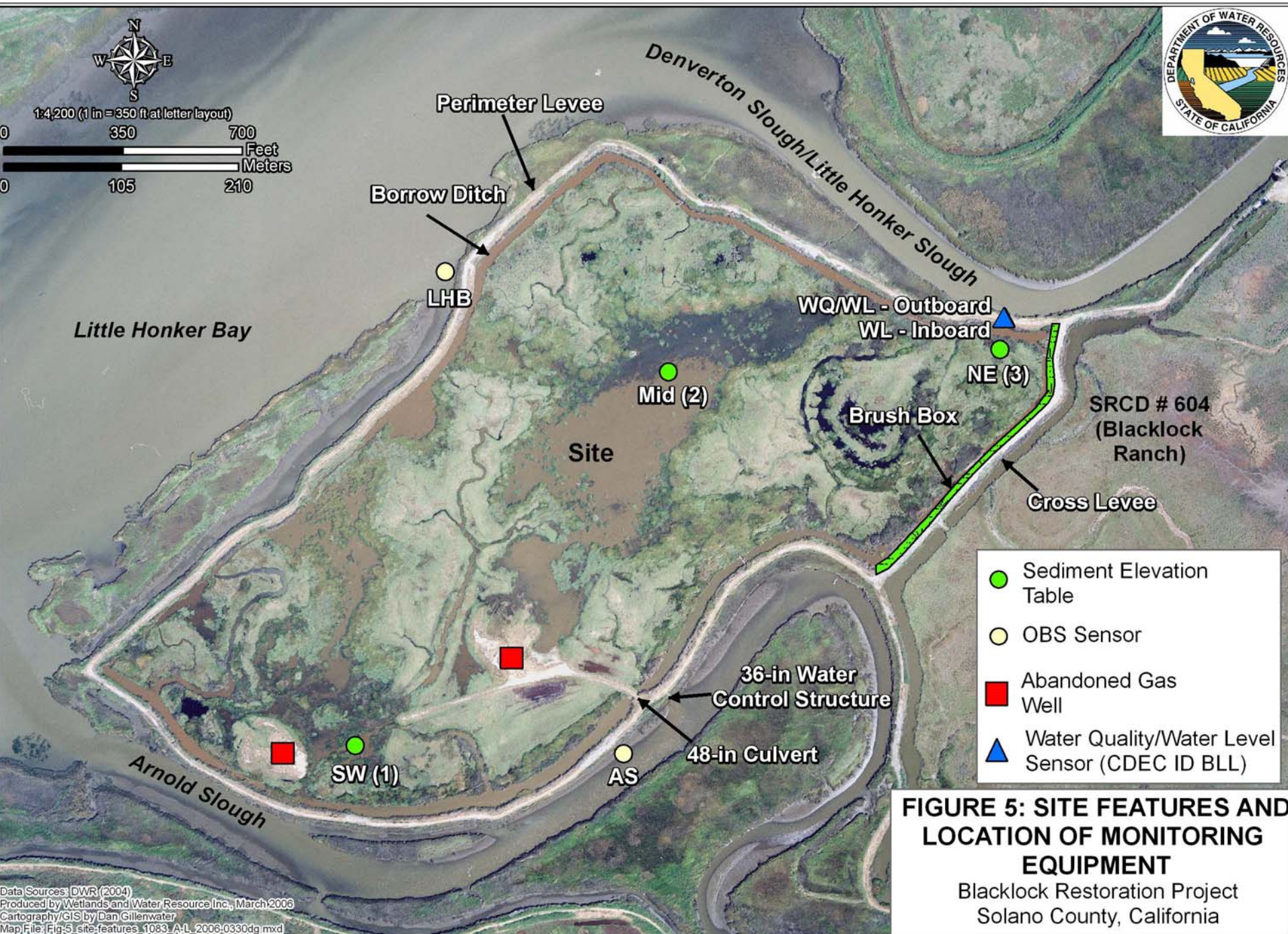

FIGURE 5: SITE FEATURES AND LOCATION OF MONITORING EQUIPMENT

Blacklock Restoration Project
Solano County, California